Appendix H

**Methodology for Predicting Potential Changes in
Sediment Oxygen Demand (SOD)**

SODPARMEST V1.1
SOD PARAMETER ESTIMATOR

Developer: Gregg Comstock, P.E.
Original Date: 3/21/06
Last Revised: 5/29/06

This program calculates the change in parameters that can exert SOD between

> • a "BASE" condition that corresponds to the QUAL2E calibrated SOD values,

> • a "NO WWTF " condition which corresponds to QUAL2E model run assuming WWTF effluent concentrations equal to zero for all parameters except dissolved oxygen and flow, and

> • a "TEST" condition which corresponds to a QUAL2E model run with different WWTF flows and effluent limits.

The difference between the BASE and NO WWTF conditions gives the maximum reduction in parameters that may contribute to SOD due to the WWTFs. This is used as a gage to compare to other WWTF treatment scenarios.

The model assumes that Phytoplankton (PHY), Periphyton (PER) and particulate WWTF CBOD (WWTF CBOD) are all parameters that can ultimately contribute to SOD.   All other CBOD in the system during dry low flow conditions is assumed to be soluble and not a contributor to SOD.

The results can be used as an estimation of the percent change in SOD that might occur if the Test Condition was implemented however one should bear in mind that the results are approximate for the following reasons:

> • the change in mass of potential SOD contributing pollutants per day divided by the bottom area in square feet is not necessarily the same as the change in the rate of oxygen demand per square foot that would be measured in the SOD test.

> • It is difficult to predict where materials that could potentially exert SOD will ultimately be deposited due to variability in flow and settling velocities.

> • WWTFs are not the only source of SOD. Decay of ambient macrophytes and detritus from outside sources (i.e., leaves from trees and organics in runoff) can also exert SOD.

Based on QUAL2E output files, the program computes the mass / day of PHY, PER in each element.   PHY and PER mass are expressed in terms of grams of oxygen demand they can ultimately exert to be comparable to CBOD (which is already expressed in terms of oxygen demand). For WWTF CBOD, the user manually inputs the WWTF flow and CBOD concentration for each scenario.

Formulas used to calculate PHY and PER in gm O / day and CBOD in gm CBOD / day are shown below.

Phytoplankton (gm O / day):

ug PHY chl a x 28.32 L x   gm   x Q elem ft3 x 86400 sec x   gm PHY   x [(.40 gm C x 2.67 gm O) + (0.08 gm N x 4.33 gm O)]
L   ft3   1x106 ug   sec   day .01 gm chl a   gm PHY   gm C   gm PHY   gm N

where   Q elem = Flow in QUAL2E element (from QUAL2E output file)
            C = Carbon
            N = Nitrogen
            O = Oxygen

2

Periphyton (gm O /day):

$$\frac{mg\ PER\ chl\ a}{ft2}\ x\ BA\ ft2\ x\ BOTCOV\ x\ \frac{gm}{1,000\ mg}\ x\ \frac{1}{V\ elem\ ft3}\ x\ \frac{Q\ elem\ ft3}{sec}\ x\ \frac{86400\ sec}{day}\ x\ \frac{gm\ PER}{.01\ gm\ chl\ a}\ x\ \frac{[(.40\ gm\ C\ x\ 2.67\ gm\ O) + (0.08\ gm\ N\ x\ 4.33\ gm\ O)]}{gm\ PER\ \ \ gm\ C\ \ \ \ gm\ PER\ \ \ \ gm\ N}$$

where   BA= Bottom area of element (from QUAL2E output file - ft2)
         BOTCOV = Fraction of BA covered with Periphyton (from QUAL2E output file - ft2)
         V elem = Volume of element (from QUAL2E output file - ft3)

WWTF CBOD (gm CBOD /day):

$$\frac{mg\ WWTF\ CBOD}{L}\ x\ PART\_FRAC\ x\ \frac{gm}{1,000\ mg}\ x\ \frac{28.32\ L}{ft3}\ x\ \frac{Q\ WWTF\ ft3}{sec}\ x\ \frac{86400\ sec}{day}$$

where: PART FRAC is the fraction of CBOD assumed to be particulate (this is specified by the User – typical values are usually 0.8 without filtration and 0.6 with filtration).

Differences between scenarios are compared at locations specified by the user where sediments are likely to accumulate (i.e., areas with low velocities or obstructions such as impoundments). At each of these specified locations, the total upstream PHY, PER and WWTF CBOD is computed for each scenario. In addition, the user may specify the fraction of PHY, PER and WWTF CBOD which is assumed to deposit and contribute to SOD at the next downstream location to see how this affects results.

Results may be interpreted as follows:

   • The NO WWTF condition represents the contribution of PHY, PER from only Nonpoint sources in the QUAL2E model.

   • The difference between the NO WWTF and BASE condition (NO WWTF – BASE) represents the maximum reduction in oxygen demanding substances attributable to the WWTF.

   • If the TEST condition is greater than the BASE condition, it is likely that the WWTF limits under the TEST condition would result in an increase in the SOD used in the BASE condition. This should be avoided if SOD is an issue.

   • If the TEST condition is less than the BASE condition, it is likely that the WWTF limits under the TEST condition would result in a decrease in the BASE condition SOD.

   • (TEST - BASE)/ BASE or (NO WWTF - BASE)/ BASE represents the percent gain or loss of PHY, PER and WWTF CBOD as compared to the BASE condition. Negative values indicate a potential reduction in SOD whereas positive values suggest a possible increase in SOD.

Operator Instructions:

1. Run QUAL2E v.5 for each of the three scenarios.
2. Copy and paste the plot files in the worksheets labeled BASE, NO WWTF, and TEST.
3. Fill out the input data on the worksheet labeled INPUT (only fill in cells shaded green)
4. Results and charts are printed on the RESULTS worksheet